
सामान्य प्रयोजनों के लिए रजलित काँच के
दर्पण — विशिष्टि
(तीसरा पुनरीक्षण)

Silvered Glass Mirrors for General
Purposes — Specification
(Third Revision)

ICS 81.040.20

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FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Glass, Glassware and Laboratoryware Sectional Committee had been approved by the Chemical Division Council.

This standard was originally published in 1965 and later revised in 1977 and 1994. In this revision, the following modifications have been incorporated:

- a) Presence of copper in coatings is not permitted;
- b) Scope has been modified;
- c) Terminology has been expanded;
- d) To protect the users from lead exposure, requirement of lead for paints used as protective coatings have been added;
- e) Reference to IS 14900 has been given for requirements like base pane, thickness, dimensions, squareness etc.;
- f) Requirement for faults have been added;
- g) Requirement for waviness has been removed;
- h) Copper accelerated acetic acid salt spray test has been added;
- j) Hot water test has been removed;
- k) Spectrophotometric method added for determination of reflectance. Also, the requirement for reflectance has been modified;
- m) Requirements and methods of test for protective coatings adhesion, condensation water and pendulum damping have been added;
- n) Method for determination of silver coating in mirror during production has been added; and
- p) Informative annex on mirrors has been added.

In the formulation of this standard, considerable assistance has been derived from the following publications:

ASTM C1503-08	Standard specification for silvered flat glass mirror
BS EN 1036-1 : 2007	Glass in building — Mirrors from silver coated float glass for internal use — Part 1: Definitions, requirements and test methods
ISO 1522 : 2006	Paints and varnishes — Pendulum damping test
ISO 2409 : 2013	Paints and varnishes — Cross-cut test
ISO 9227 : 2017	Corrosion tests in artificial atmospheres — Salt spray tests
ISO 25537 : 2008	Glass in building — Silvered, flat-glass mirror

The composition of the committee responsible for the formulation of the standard is listed in Annex J.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SILVERED GLASS MIRRORS FOR GENERAL PURPOSES — SPECIFICATION

(*Third Revision*)

1 SCOPE

This standard prescribes requirements and methods of sampling and test for mirrors from silver coated float glass for interior application.

This standard applies only to mirrors from silvered glass manufactured from flat annealed clear or tinted float glass, supplied in standard sizes as cut finished.

NOTE — This standard is not applicable for mirrors from silvered glass used in aggressive and/or constantly high humidity atmospheres like horse riding halls, swimming pools, medical baths, saunas, high humidity baths etc. This standard is also not applicable to reflective glass for external glazing applications.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

<i>IS No.</i>	<i>Title</i>
IS 133 : 2013	Enamel, interior: (a) undercoating (b) finishing — Specification (<i>fifth revision</i>)
IS 264 : 2005	Nitric acid (<i>third revision</i>)
IS 266 : 1993	Sulphuric acid (<i>third revision</i>)
IS 513 (Part 1) : 2016	Cold reduced carbon steel sheet and strip: Part 1 Cold forming and drawing purposes (<i>sixth revision</i>)
IS 1070 : 1992	Reagent grade water (<i>third revision</i>)
IS 1382 : 1981	Glossary of terms relating to glass and glassware (<i>first revision</i>)
IS 2932 : 2013	Enamel, synthetic, exterior: (a) undercoating (b) finishing — Specification (<i>fourth revision</i>)
IS 7809 (Part 2) : 1977	Specification for pressure sensitive adhesive tapes for electrical purpose: Part 2 Methods of test

IS 14900 : 2018 Transparent float glass — Specification (*first revision*)

IS 16231 (Part 2) : 2019 Use of glass in buildings — Code of practice: Part 2 Energy and light (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the terms and definitions given in IS1382 and IS 14900, in addition to the following shall apply.

3.1 Blister

Separation of silver coating or the protective coating.

3.2 Cloud

Frosted appearance in the reflected image from a silver coating.

3.3 Cluster

Group of not fewer than three spot faults separated by not more than 50 mm.

3.4 Colour Spots

Alteration of the reflective coating in the form of small, generally coloured spots.

3.5 Copper-Free Mirror from Silver-Coated Float Glass

Flat annealed clear or tinted float glass whose rear surface has been coated with a protected reflective silver deposit without use of copper.

3.6 Corner On/Off

Protrusion or indentation in the depth direction of the edge of the corner of mirror from the cut line.

3.7 Cut Size

Mirror cut to a size that is intended for final use. It is not intended for re-cutting, but may be subject to further processing like edge working, drilling, face decoration, etc.

3.8 Drip

Spot faults generated due to dropping and adhering of tin with the glass surface.

3.9 Edge Corrosion

Change in the colour or level of reflectance along the mirror edge as a result of degradation of the silver coating from external sources.

3.10 Edge Fault

Fault that affects the as-cut edge of the silvered glass, which includes slicing on/off, corners on/off, chips, shell chips, flare etc.

3.11 Flare

Protrusion in the length or width direction of the edge of a piece of mirror from the cut line.

3.12 Glass Appearance Faults

Faults which alter the visual quality of the mirror from silver-coated float glass. They can be spot and/or linear and/or enlarged area faults.

3.13 Hairline Scratch

Very fine linear or circular scratch or line which can barely be seen.

3.14 Halo

Distortion zone around gaseous inclusion or stone.

3.15 Optical Faults

Faults directly associated with the distortion of the reflected image.

3.16 Paint Peel Off

Loss of the silver coating or the protective coating.

3.17 Pinhole

Holes in silver coating or protective coating.

3.18 Protective Coating(s) Fault

Pinhole, burst bubble, scratches or loss of adhesion of the protective coating(s).

3.19 Reflective Silver Coating Faults

Faults in the reflective silver layer which will alter the appearance of the silvered glass. They consist of scratches, stain, colour spots and edge corrosion.

3.20 Shell Chip

Circular indentation in the mirror edge due to breakage of a small fragment.

3.21 Slicing On/ Off

Protrusion or indentation in the depth direction of the edge of the piece of mirror from the cut line.

3.22 Stain

Alteration of the reflective coating characterized by

a more or less brownish, yellowish or grayish colouration of zones which can sometimes cover the whole reflective surface.

3.23 Stock/Standard Size

Mirrors supplied with as-cut edges, which are intended for further processing.

3.24 Weathering

Discoloration of the silver coating caused due to the surface properties of a material flat glass.

4 REQUIREMENTS

4.1 General

Mirrors shall consist of glass sheet coated with silver on one surface. The silver shall be protected by a suitable protective paint coating. The paint used as protective coating may be tested as per IS 101 (Part 8/Sec 5) and when thus tested the material shall not contain lead or compounds of lead or mixtures of both, calculated as metallic lead, exceeding 90 ppm.

4.2 Base Pane

The base glass/pane used for mirrors shall be flat, transparent and clear or tinted. In case of clear glass, it shall comply with the requirements prescribed in IS 14900.

4.3 Thickness

Thickness of silvered glass mirror shall be as prescribed in 4.3.1 of IS 14900. The actual thickness shall be the average of four measurements, taken to the nearest 0.01 mm, one taken at the center of each side.

4.4 Dimensions

Dimensions of silvered glass mirror shall be as prescribed in 4.3.2 of IS 14900.

4.5 Squareness

Squareness of silvered glass mirror shall be as prescribed in 4.3.3 of IS 14900.

4.6 Silvering

Silvering shall be a coating of deposited silver. It shall be free from defects or blemishes in the reflecting surface such as lifting or separation of the silver from the glass, sulphide or other spots, haze or any other visible defects. The amount of silver deposit shall not be less than 700 mg/m² when determined in accordance with the method prescribed in E-5.2.

4.7 Protective Coating

4.7.1 A suitable protective paint coating shall be applied over the base silver coating. This paint coating shall not crack or peel the silver coatings due to change in the atmospheric temperature or age-drying.

4.7.2 There shall be no copper used as a coating in the mirror. Protective coating shall be tested for presence of copper as prescribed in E-5.3.

4.8 Requirements for Glass, Reflective Coating, Edge and Protective Coating Faults

4.8.1 Glass Faults

Glass faults shall be assessed using the inspection method prescribed in 4.8.5. The dimension and number of hairline scratches, scratches and spot

faults which cause disturbance to vision shall be as per Table 1.

4.8.2 Reflective Silver Coating Faults

Reflective silver coating faults shall be assessed using the inspection method prescribed in 4.8.5. Note the presence of scratches, stains, color spots and edge deterioration that cause disturbance to the image. Acceptance level for reflective coating faults shall be as per Table 1.

4.8.3 Protective Coating(s) Faults

Using the inspection method prescribed in 4.8.5, the presence of pin holes, burst bubbles, flaking of the protective coating along the edges or other faults in the protective coating(s) shall be noted looking at the protective-coated side (backside) of the mirror. Acceptance level for protective coating(s) shall be as per Table 1.

Table 1 Acceptance Levels for Glass Faults, Reflective Silver-Coating Faults and Protective Coating(s) Faults
(Clauses 4.8.1, 4.8.2 and 4.8.3)

Linear Defects (mm)		Defects /m ² , Max, for all Sizes of Mirror with Clear or Tinted Glass Substrate
Brush marks	≤ 50	0.375
	>50	0
Scratches	≤ 50	0.139
	>50	0
Dimension of Spot Faults ¹⁾ (mm)	Defects /m ² , Max, for all Sizes	
	Mirror with Clear Glass Substrate	Mirror with Tinted Glass Substrate
≤ 0.6	Accepted ²⁾	Accepted ²⁾
> 0.6 and ≤ 1.5	1	1.5
> 1.5 and < 3	0.1	0.15
> 3	0	0
1) The dimensions stated are with effect of the halo. 2) Accepted, provided they do not form a cluster.		

4.8.4 Edge Faults

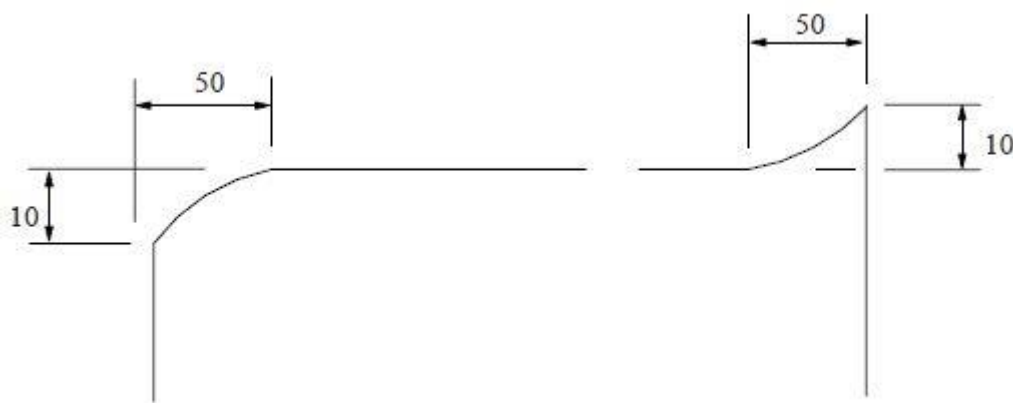
4.8.4.1 Chips or shells

For stock sizes, entrant or emergent chips or shells, visible under the conditions in 4 shall be accepted provided they do not exceed a maximum length or height of 10 mm and depth of half the nominal glass thickness. For cut sizes, entrant or emergent chips or shells, visible under the conditions in 4.8.5 shall be accepted provided they are not greater than 1.5 mm deep.

4.8.4.2 Corners on/off

For stock sizes, occasional corners on/off visible under the conditions in 4.8.5, as per Fig. 1 shall be allowed. For cut sizes, corners on/off shall not be allowed.

NOTE — It is recommended that not more than 5% of sheets in a lot in case of stock sizes may be affected by corners on/off.



All dimensions are in mm

FIG.1 DIMENSIONS OF CORNER ON/OFF

4.8.4.3 Vented (cracked) edges

Vented (cracked) edges, visible under conditions described in 4.8.5, shall not be allowed with either stock/standard sizes or cut sizes.

4.8.5 Visual Inspection Method

The silvered mirror shall be observed in a vertical position, with the naked eye and under normal

diffused daylight conditions (300 lux to 600 lux at the silvered mirror), from a distance of 1 000 mm. The direction of observation shall be at right angles, to the silvered mirror. The use of an additional lighting source, for example, spotlight, is not allowed.

4.9 Silvered glass mirror shall also satisfy the requirements prescribed in Table 2.

Table 2 Requirements for Mirror Coating Quality and Durability

(Clause 4.9, Table 3, Annexes A, B, C, D and G-1.5)

Sl No.	Requirement	Acceptance Criteria	Method of Test, Ref to Annex
(1)	(2)	(3)	(4)
i)	Reflectance (For clear float glass ¹⁾)	Table 3	A-1 or A-2
ii)	Protective coating adhesion	Classification number 2, if brush is used or Classification number 3, if tape is used	B
iii)	Copper accelerated acetic acid salt spray test	Stain or cloud in silver coating – None Bubbles in protective coating – None Edge corrosion – ≤ 1.5 mm Number of colour spots – > 3 mm – None > 0.5 mm and ≤ 3 mm – 2 > 0.2 mm and ≤ 0.5 mm – 3	C
iv)	Condensation water test	After 480 h, Edge corrosion ≤ 0.2 mm Spots – 1 allowed, if diameter of spot ≤ 0.3 mm	D
v)	Pendulum damping test	> 125 s	F

1) Silvered mirrors made from tinted float glass have a reflectance lower than those made from clear glass.

Table 3 Requirement for Reflectance
(Table 2)

SI No.	Nominal Thickness, mm	Reflectance, percentage, <i>Min</i>
(1)	(2)	(3)
i)	≤ 2	83
ii)	2.5	83
iii)	3	83
iv)	3.2	83
v)	3.5	83
vi)	4	83
vii)	5	83
viii)	5.5	83
ix)	6	83
x)	8	80
xi)	10	80
xii)	12	80

5 PACKING AND MARKING

5.1 Packing

5.1.1 Mirrors shall be packed as agreed to between the purchaser and the supplier.

5.1.2 Each box/package shall be marked with the following information:

- a) Quality of glass used as 'F' for float;
- b) Indication of the source of manufacture;
- c) Lot number or batch number or date of manufacture for traceability; and
- d) Thickness, in mm.

5.2 Marking

Each mirror shall be marked with the following information:

- a) Quality of glass used as 'F' for float;
- b) Indication of the source of manufacture;

c) Lot number or batch number or date of manufacture for traceability; and

d) Thickness, in mm.

5.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

6 SAMPLING

Representative samples of mirrors shall be drawn and conformity of the material to the requirements of this specification shall be determined in accordance with the procedure prescribed in Annex G.

ANNEX A

[Table 2, Sl No. (i)]

REFLECTANCE TEST FOR MIRRORS

A-1 PROJECTOR METHOD

A-1.1 Apparatus

A-1.1.1 Light Source

A 500 watt projector with a standard lamp which can project almost parallel incident light and having a diameter of at least 19 mm.

A-1.1.2 Light Receptors and Indicator

The accuracy including the receptor shall be not more than ± 2 percent of the maximum scale value or not more than ± 10 percent of the magnitude of reading, whichever is less. However, the reflectance may be obtained by calculation after measurement with the illuminance meter.

A-1.2 Procedure

The receptor is arranged on the optical axis of the projector of a light source as given in below fig. when there is no incident light on the receptor, the scale of an indicator is aligned with the zero by a zero-adjustment dial. Further when the light of the projector is directly received the scale with 100 percent by an indication adjustment dial.

Then, the mirror to be measured is placed before the projector as shown in Fig. 2. The reflected light is received by moving a receptor and the scale of the indicator at the time is read out.

A-1.3 Result

The reflectance of the mirror shall be measured as the percentage of the indicator reading without mirror.

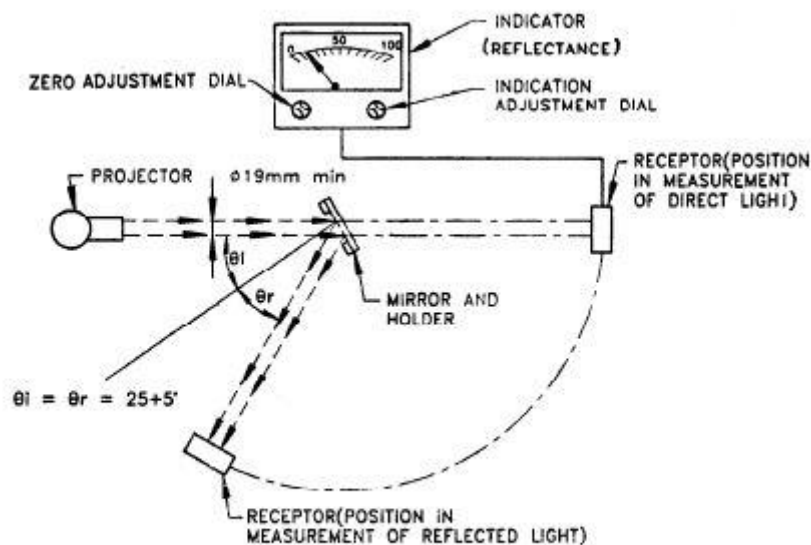


FIG. 2 REFLECTANCE TEST FOR MIRRORS

A-2 SPECTROPHOTOMETRIC METHOD

Measurement of reflectance shall be undertaken with the angle of incidence of the light within 8° of normal and D65 Illuminant [see 6.1 of IS 16231 (Part 2)]. Any commercially available calibrated spectrophotometer may be used for reflectance measurement.

The wavelength calibration and the photometric linearity of commercial spectrophotometers shall be

checked periodically using reference materials obtained from metrological laboratories.

The wavelength calibration shall be performed by measuring glass plates which feature relatively sharp absorption bands at specified wavelengths; the photometric linearity shall be checked using grey filters with a certified transmittance.

The light reflectance shall be calculated using the following equation [see 6.1 of IS 16231 (Part 2)],

$$\rho_v = \frac{\sum_{\lambda=380nm}^{780nm} \rho(\lambda)V(\lambda)\Delta\lambda}{\sum_{\lambda=380nm}^{780nm} D_\lambda V(\lambda)\Delta\lambda}$$

where

$\rho(\lambda)$ = spectral reflectance

D_λ = relative spectral distribution of illuminant D65.

$V(\lambda)$ = spectral luminous efficiency for photopic vision defining the standard observer for photometry

$\Delta\lambda$ = wavelength interval.

Normalized relative spectral distribution values shall be as per Table 5 of IS 16231 (Part 2).

ANNEX B

[Table 2, Sl No. (ii)]

PROTECTIVE COATING ADHESION

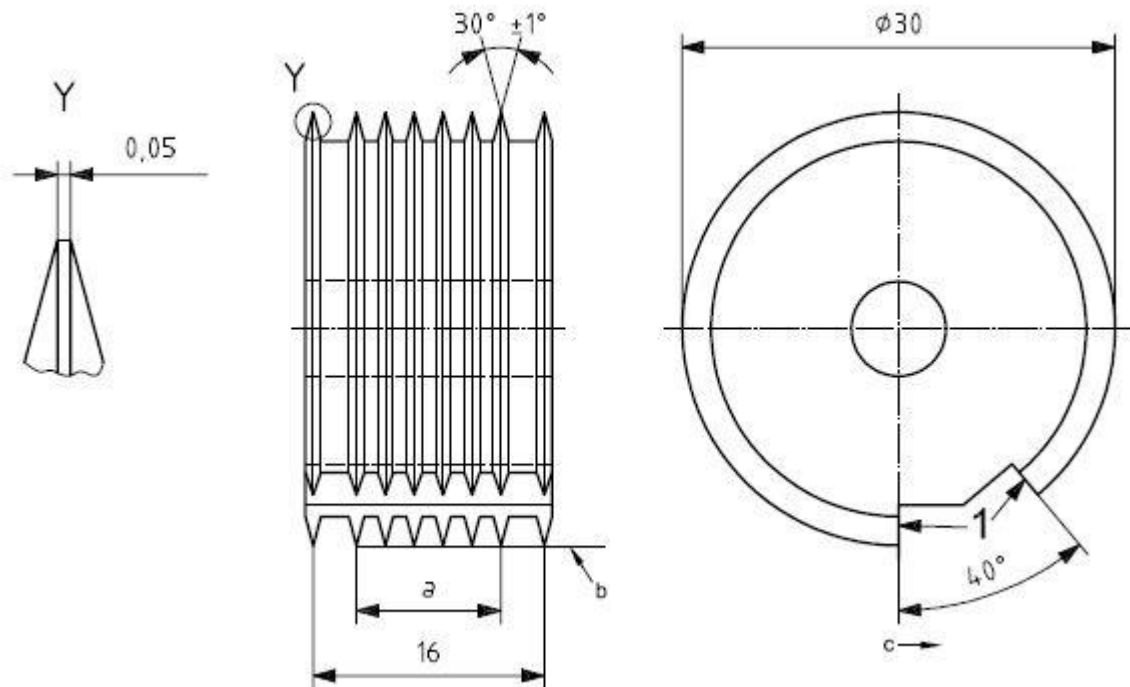
B-1 GENERAL

The adhesion of the protective coating(s), excluding the metallic layer, shall be assessed by means of the 'cross cut test'. The test shall be carried out manually, using the six bladed cutting tool (see Fig. 3) with a cut spacing of 1 mm. The specimen may be evaluated using either the soft brush or the pressure sensitive tape.

B-2 APPARATUS

B-2.1 Cutting Tool

A multi-blade cutting tool shall have six cutting edges spaced 1 mm apart (see Fig.3). The width across the six cutting edges, a , shall be 5 mm for a tool which has a cutting-edge spacing of 1 mm. When the cutting edge has worn to 0.1 mm, it shall be reground. The guide edges and the cutting edges shall lie on the same diameter.



Key

- 1 Cutting edges
- a Width across all six cutting edges
- b Guide edges and cutting edges lie on same diameter
- c Direction of cut

FIG.3 MULTI BLADE CUTTING TOOL

B-2.2 Soft Brush

B-2.3 Pressure Sensitive Adhesive Tape

Unless otherwise agreed, adhesive tape with an adhesive strength between 6 N per 25 mm width and 10 N per 25 mm width [determined in accordance with IS 7809 (Part 2)] may be used. The tape shall be at least 50 mm wide.

NOTE — Transparent tape is recommended.

B-3 TEST SPECIMEN

The dimensions of the specimen shall be mutually agreed upon between the purchaser and the supplier, but the specimen shall have a minimum area of 10 000 mm², for example, 100 mm × 100 mm, 70 mm × 150 mm, 150 mm × 150 mm.

B-4 PROCEDURE

B-4.1 Place the test panel on a rigid, flat surface to prevent any deformation of the panel during the test. Before the test, inspect the cutting edge of the blade and maintain its condition by sharpening or replacement.

Hold the cutting tool with the blade normal to the test surface. With uniform pressure on the cutting tool, cut the coating at a uniform cutting rate. All the cuts shall penetrate to the substrate surface.

Repeat this operation, making further parallel cuts of equal number, crossing the original cuts at 90° to them so that a lattice pattern is formed.

B-4.2 Evaluate the protective coatings adhesion using either the soft brush (*see B-4.3*) or the pressure sensitive tape (*see B-4.4*).

B-4.3 Brush

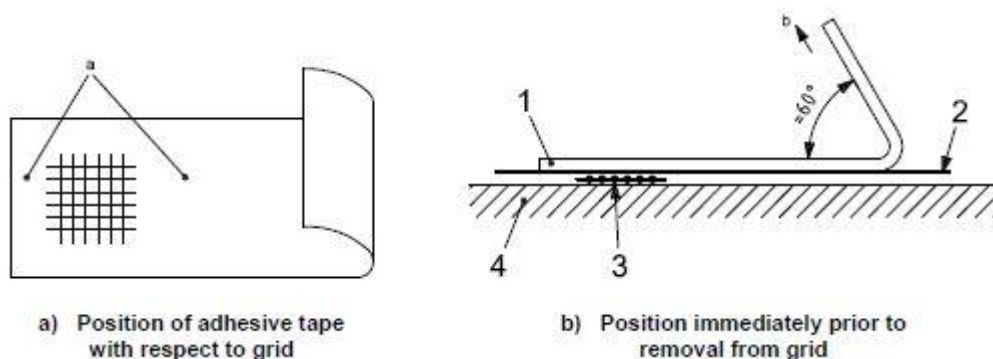
Brush the panel lightly with the soft brush several

times backwards and several times forwards along each of the diagonals of the lattice pattern.

B-4.4 Tape

Remove two complete laps from a reel of the adhesive tape and discard. Remove an additional length at a steady rate and cut a piece approximately 75 mm long.

Place the centre of the tape over the lattice in a direction parallel to one set of cuts and smooth the tape into place over the area of the lattice and for a distance of at least 20 mm beyond with a finger. To ensure good contact with the coating, rub the tape firmly with a fingertip or fingernail. The colour of the coating seen through the tape is a useful indication of overall contact. Within 5 min of applying the tape, remove the tape by grasping the free end and pulling it off steadily in 0.5 s to 1.0 s at an angle which is as close as possible to 60° (*see Fig. 4*).



Key

- 1 Tape
- 2 Coating
- 3 Cuts
- 4 Substrate
- a Smoothed down
- b Direction of removal

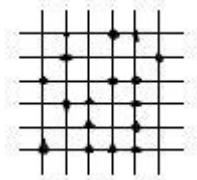

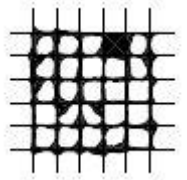
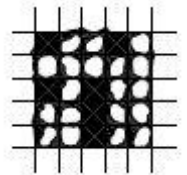
FIG. 4 APPLICATION OF ADHESIVE TAPE

NOTES

1 For coatings made up of more than one layer, it is recommended that the tape application and removal operation be carried out at least once in each direction of the lattice pattern.

2 It is recommended that the tape be retained for reference purposes, for example by attaching it to a sheet of transparent film.

B-5 CLASSIFICATION OF TEST RESULTS

Sl No.	Classification	Description	Appearance of Surface of Cross-Cut Area from which Flaking has Occurred
(1)	(2)	(3)	(4)
i)	0	The edges of the cuts are completely smooth; none of the squares of the lattice is detached.	—
ii)	1	Detachment of small flakes of the coating at the intersections of the cuts. A cross-cut area not greater than 5% is affected.	
iii)	2	The coating has flaked along the edges and/or at the intersections of the cuts. A cross-cut area greater than 5%, but not greater than 15%, is affected.	
iv)	3	The coating has flaked along the edges of the cuts partly or wholly in large ribbons, and/or it has flaked partly or wholly on different parts of the squares. A cross-cut area greater than 15%, but not greater than 35%, is affected.	
v)	4	The coating has flaked along the edges of the cuts in large ribbons and/or some squares have detached partly or wholly. A cross-cut area greater than 35%, but not greater than 65%, is affected.	
vi)	5	Any degree of flaking that cannot even be classified by classification 4.	—

ANNEX C

[Table 2, Sl No. (iii)]

COPPER-ACCELERATED ACETIC ACID SALT SPRAY TEST

C-1 TEST SOLUTION**C-1.1 Salt Solution**

A salt solution having a concentration of 50 ± 5 g/l shall be prepared by dissolving sodium chloride in distilled or deionized water (*see* IS 1070). Sodium chloride used shall not contain a mass fraction of the heavy metals copper (Cu), nickel (Ni) and lead (Pb) in total more than 0.005%. It shall not contain a mass fraction of sodium iodide more than 0.1% and a mass fraction of total impurities more than 0.5%, calculated for dry salt.

C-1.2 Adjustment of pH

C-1.2.1 Dissolve a sufficient mass of copper(II) chloride dihydrate ($\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$) in the salt solution (*see* C-1.1) to produce a concentration of $0.26 \text{ g/l} \pm 0.02 \text{ g/l}$ [equivalent to $0.205 \text{ g} \pm 0.015 \text{ g}$ of CuCl_2 per litre].

C-1.2.2 Add a sufficient amount of glacial acetic acid to the salt solution (C-1.1) to ensure that the pH of samples of sprayed solution collected in the test cabinet (C-2.2) is between 3.1 and 3.3 at $25^\circ\text{C} \pm 2^\circ\text{C}$. If the pH of the solution initially prepared is 3.0 to 3.1, the pH of the sprayed solution is likely to be within the specified limits. Check the pH using electrometric measurement. Measurements of pH shall be done using electrodes suitable for measuring in weakly buffered sodium chloride solutions in deionized water. Make any necessary corrections by adding glacial acetic acid, sodium hydroxide, or sodium bicarbonate of analytical grade.

C-1.2.3 If necessary, filter the solution before placing it in the reservoir of the apparatus, to remove any solid matter which might block the apertures of the spraying device.

C-2 APPARATUS**C-2.1 Component Protection**

All components in contact with the spray or the test solution shall be made of, or lined with, materials resistant to corrosion by the sprayed solution and which do not influence the corrosivity of the sprayed test solutions.

The supports for the test specimen shall be constructed such that different substrate types do not influence each other. It shall also be constructed so that the supports themselves do not influence the test specimens.

C-2.2 Spray Cabinet

The cabinet shall be such that the conditions of homogeneity and distribution of the spray are met. Due to the limited capacity of cabinets smaller than 0.4 m^3 , the effect of the loading of the cabinet on the distribution of the spray and temperature shall be carefully considered. The solution shall not be sprayed directly onto test specimens but rather spread throughout the cabinet so that it falls naturally down to them. The upper parts of the cabinet shall be designed so that drops of sprayed solution formed on its surface do not fall on the test specimens being tested.

The size and shape of the cabinet shall be such that the collection rate of solution in the cabinet is within the limits measured as specified in C-5.5. Preference shall be given to apparatus that has a means for properly dealing with fog after the test, prior to releasing it from the building for environmental conservation, and for drawing water prior to discharging it to the drainage system.

C-2.3 Heater and Temperature Control

An appropriate system shall maintain the cabinet and its contents at the specified temperature (*see* Table 5). The temperature shall be measured at least 100 mm from walls and radiant heat sources.

C-2.4 Spraying Device

The device for spraying the salt solution comprises a supply of clean air, of controlled pressure and humidity, a reservoir to contain the solution to be sprayed, and one or more atomizers.

The compressed air supplied to the atomizers shall be passed through a filter to remove all traces of oil or solid matter, and the atomizing pressure shall be at an overpressure of 70 kPa to 170 kPa. The pressure is typically $98 \text{ kPa} \pm 10 \text{ kPa}$ but can vary depending on the type of cabinet and atomizer used.

In order to prevent the evaporation of water from the sprayed droplets (aerosol), the air shall be humidified before entering the atomizer by passing through a suitable humidifier. The humidified air shall be saturated such that the concentration of the fallout solution falls within the specifications of **C- 1.1**. The humidified air shall also be heated such that when mixed with the salt solution, there is no significant disturbance of the temperature in the cabinet. The appropriate temperature depends on the

pressure used and on the type of atomizer nozzle. Temperature, pressure or humidification, or a combination thereof, shall be adjusted so that the rate of collection of the spray in the cabinet and the concentration of the collected spray are kept within the specified limits (*see C-5.5*). A commonly used humidifier is the saturation tower, where temperature and pressure are controllable. Table 4 gives guiding values on temperature and pressure combinations for the saturation tower.

Table 4 Guiding Values for the Temperature of the Hot Water in the Saturation Tower
(Clause C-2.4)

SI No.	Atomizing Overpressure, kPa	Guiding Values for the Temperature of the Hot Water in the Saturation Tower when Performing the Different Salt Spray Test, °C
(1)	(2)	(3)
i)	70	61
ii)	84	63
iii)	98	64
iv)	112	66
v)	126	67
vi)	140	69
vii)	160	70
viii)	170	71

The atomizers shall be made of inert material. Baffles may be used to prevent direct impact of the spray on the test specimens, and the use of adjustable baffles is helpful in obtaining uniform distribution of the spray within the cabinet. For this purpose, a dispersion tower equipped with an atomizer may also be helpful.

The salt solution supplied to the nozzle shall be kept stable to ensure a continuous and uniform fall out as described in **C-5.5**. A stable level of spraying can be achieved by either controlling the level of salt solution in the reservoir or restricting the flow of salt solution to the nozzle such that a continuous spray is achieved.

Distilled or deionized water with conductivity not higher than 20 $\mu\text{S}/\text{cm}$ at $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ shall be used for humidification of spray air.

C-2.5 Collecting Devices

At least two collecting devices shall be used to check

the homogeneity of the spraying of the cabinet. Suitable funnels shall be made of chemically inert material, with the stems inserted into graduated cylinders or other similar containers and have a diameter of 100 mm, which corresponds to a collecting area of approximately 80 cm^2 . The collecting devices shall be placed in the zone of the cabinet where the test specimens are placed, one close to an inlet of spray and one remote from an inlet. They shall be placed so that only mist, and not liquid falling from specimens or from parts of the cabinet, is collected.

C-3 METHOD FOR EVALUATING CABINET CORROSIVITY

C-3.1 To check the reproducibility and repeatability of the test results for one piece of apparatus, or for similar items of apparatus in different laboratories,

it is necessary to verify the apparatus at regular intervals as described in C-3.2 to C-3.4.

NOTE — During permanent operation, a reasonable time period between two checks of the corrosivity of the apparatus is generally considered to be 3 months.

To determine the corrosivity of the tests, reference specimens made of steel shall be used.

C-3.2 Reference Specimens

To verify the apparatus, use at least four reference specimens of $1.0 \text{ mm} \pm 0.2 \text{ mm}$ thickness and $150 \text{ mm} \times 70 \text{ mm}$ of CR4-grade steel in accordance with IS 513 (Part 1) with an essentially faultless surface) and a matt finish (arithmetical mean deviation of the profile $Ra = 0.8 \text{ } \mu\text{m} \pm 0.3 \text{ } \mu\text{m}$). Cut these reference specimens from cold-rolled plates or strips.

Thoroughly clean the reference specimens with an appropriate organic solvent (such as a hydrocarbon with a boiling point between $60 \text{ }^{\circ}\text{C}$ and $120 \text{ }^{\circ}\text{C}$), using a clean soft brush or soft cloth, non-woven lint free cloth that does not leave any remains, or an ultrasonic cleaning device. Carry out the cleaning in a vessel full of solvent. After cleaning, rinse the reference specimens with fresh solvent and then dry them. Cleaning shall eliminate all those traces (dirt, oil or other foreign matter) that can influence the test results.

Determine the mass of the reference specimens to $\pm 1 \text{ mg}$. Protect one face of the reference specimens with a removable coating, for example, an adhesive plastic film. The edges of the reference specimens may be protected by the adhesive tape as well.

Each reference specimen shall be used for evaluating cabinet corrosivity only once.

C-3.3 Arrangement of the Reference Specimens

Position at least four steel reference specimens in four quadrants (if six specimens are available, place them in six different positions including four quadrants) in the zone of the cabinet where the test specimens are placed, with the unprotected face upwards, and at an angle of $20 \pm 5^{\circ}$ from the vertical. The support for the reference specimens shall be made of, or coated with, inert materials such as plastics. The lower edge of the reference specimens shall be in level with the top of the salt spray collector.

The cabinet should be verified during the testing of test specimens. If this is the case, great care shall be taken that the specimens do not affect each other.

Otherwise, the cabinet shall be filled with substitute specimens to maintain the homogeneity of the cabinet. The verification procedure shall be performed using the same settings as for the test runs.

C-3.4 Determination of Mass Loss (Mass Per Area)

The test duration shall be 24 h. At the end of the test, immediately take the reference specimens out of the test cabinet and remove the protective coating. Remove the corrosion products by mechanical and chemical cleaning. An option for chemical cleaning is the use of a solution with a mass fraction of 20% of diammonium citrate $[(\text{NH}_4)_2\text{HC}_6\text{H}_5\text{O}_7]$ (recognized analytical grade) in water for 10 min at $23 \text{ }^{\circ}\text{C}$.

After each stripping, thoroughly clean the reference specimens at ambient temperature with water, then with ethanol, followed by drying.

Weigh the reference specimens to the nearest 1 mg. Divide the determined mass loss by the area of the exposed surface area of the reference specimen in order to assess the metal mass loss per square metre of the reference specimen.

It is recommended that freshly prepared solution be used during each procedure for the removal of corrosion products.

C-3.5 Satisfactory Performance of Cabinet

The cabinet shall be deemed to have performed satisfactorily if the mass loss of steel reference specimen is within the allowed range of mass loss of $55 \pm 15 \text{ g/m}^2$.

C-4 TEST SPECIMENS

The dimensions of the specimen shall be mutually agreed upon between the purchaser and the supplier, but the specimen shall have a minimum area of $10\,000 \text{ mm}^2$, for example, $100 \text{ mm} \times 100 \text{ mm}$, $70 \text{ mm} \times 150 \text{ mm}$, $150 \text{ mm} \times 150 \text{ mm}$.

C-5 PROCEDURE

C-5.1 Arrangement of Test Specimens

The test specimens shall be placed in the cabinet so that they are not in the direct line of travel of the spray from the atomizer. The angle at which the surface of the test specimen is exposed in the cabinet is very important. The specimen shall, in principle,

be flat and placed in the cabinet facing upwards at an angle as close as possible to 20° to the vertical. This angle shall, in all cases, be within the limits 15° to 25°. In the case of irregular surfaces, for example, entire components, these limits shall be adhered to as closely as possible.

The test specimens shall be arranged so that they do not come into contact with the cabinet and so that surfaces to be tested are exposed to free circulation of spray. The specimens may be placed at different levels within the cabinet, as long as the solution does

not drip from specimens or their supports at one level onto other specimens placed below. However, for a new examination or for tests with a total duration exceeding 96 h, location permutation of specimens is permitted.

The supports for the test specimens shall be made of inert non-metallic material. If it is necessary to suspend specimens, the material used shall not be metallic but shall be synthetic fibre, cotton thread or other inert insulating material.

C-5.2 Operating conditions shall be as prescribed in Table 5.

Table 5 Operating Conditions
(Clause C-5.2, C-5.5, C-2.3)

Sl No.	Operating Parameter	Prescribed Value
i)	Temperature	50 °C ± 2 °C
ii)	Average collection rate for a horizontal collecting area of 80 cm ²	1.5 ± 0.5 ml/h
iii)	Concentration of sodium chloride (collected solution)	50 ± 5 g/l
iv)	pH of collected solution	3.1 to 3.3

NOTE – The ± tolerances given are the allowable operational fluctuations, which are defined as the positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions. This does not mean that the set value may vary by plus/minus the amount indicated from the given value.

C-5.3 Check the collection rate and other test conditions in the test cabinet, filled to a similar extent as during the test. An empty or a completely filled cabinet behaves differently. After it has been confirmed that the test conditions are within a specified range, stop spraying the salt solution, fill the test cabinet with test specimens and start the test.

Evaporation of collected solution inside the cabinet can have an effect on the concentration and pH. Care should be taken to only measure solution that has not been subject to significant evaporation.

C-5.4 The duration of test shall be 120 h. Interruptions of the test shall be minimized. The cabinet shall be opened only for brief visual inspections of the test specimens in position and for replenishing the salt solution in the reservoir, if such replenishment cannot be carried out from outside the cabinet. The total opening time per day shall not exceed 1 h.

NOTE — A periodic visual examination of specimens under test for a predetermined period may be carried out, but the

surfaces under test shall not be disturbed, and the period for which the cabinet is open shall be the minimum necessary to observe and record any visible changes.

C-5.5 The solution collected in each of the collecting devices (*see* C-2.5) shall have a sodium chloride concentration and a pH value within the ranges given in Table 5.

The average rate of collection of solution in each device shall be measured over a minimum period of 24 h of continuous spraying. A daily checking of the collection rate during the operation of the cabinet is recommended.

C-5.6 The test solution which has been sprayed shall not be re-used.

C-5.7 During operation, the tank for the salt solution shall be covered by a lid to prevent dust or other contaminants from influencing the solution and to prevent the concentration of sodium chloride and the pH from fluctuating.

C-6 TREATMENT OF SPECIMENS AFTER TEST

At the end of the test period, remove the test specimens from the cabinet and allow them to dry for 0.5 h to 1 h before rinsing, in order to reduce the risk of removing corrosion products. Before they are

examined, carefully remove the residues of spray solution from their surfaces. A suitable method is to rinse or dip the test specimens gently in clean running water, at a temperature not exceeding 40 ° C, and then to dry them immediately in a stream of air, at an overpressure not exceeding 200 kPa and at a distance of approximately 300 mm.

ANNEX D

[Table 2, Sl No. (iv)]

CONDENSATION WATER TEST IN CONSTANT ATMOSPHERE**D-1 GENERAL**

This test method describes the general conditions which have to be observed when submitting specimens to condensation water-constant atmospheres, in order to ensure that the results of tests carried out in different laboratories are reproducible. The tests are designed to determine the behaviour of the specimens in humid ambient atmospheres, and to pinpoint any defects of the protection of the specimens against corrosion. The behaviour of the specimens in these test atmospheres does not, however, enable any direct assertions to be made in respect of the service life expectation of the components tested under real conditions of use. The shape and the preparation of the specimens, the duration of the test, the evaluation of the test and the assessment of the test results do not form part of the subject matter of this test method.

D-2 TEST CONDITIONS

Condensation water test atmospheres promote the condensation of atmospheric humidity on the surfaces of specimens, the temperatures of which are lower than the temperature of the saturated air in the test cabinet, due to radiation onto the cabinet walls or to the cooling of the specimen. The constant atmospheric temperature in the test cabinet during the condensation process of the condensation water test shall be $40\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$. The quantity of condensation water formed on the surface of the specimen may also have an important influence on the action of the condensation water; this quantity will be affected by the ambient temperature in the installation room or by the cooling of the specimen. The condensate which drips off the specimen consists of condensation water and also in some instances of solid and liquid constituents of the specimens dissolved in the condensation water or mixed in it. Reproducible results can only be expected on condition that the test atmosphere is the same and that the test procedure is the same.

D-3 CLIMATIC TESTING DEVICE**D-3.1 Climatic Chamber**

A vapour-tight climatic chamber is essential for

testing with a warm and humid atmosphere. The material of the inner walls shall be corrosion-resistant and shall not affect the specimens. The climatic chamber shall be usually equipped with a floor trough which acts as the receptacle for the quantity of water prescribed in **D-4.1**. The test cabinet conditions shall be achieved by heating the water in the floor trough.

If the quantity of heat introduced via the water is insufficient to heat up the air in the test cabinet to the required temperature, then this air shall be heated up additionally.

NOTE — The heating-up time will depend on the nature and quantity of the specimens, and also on the ratio of the water surface of the floor trough to the wall surface of the test cabinet, and on the water temperature. The water temperature shall not exceed $60\text{ }^{\circ}\text{C}$. The dimensions of the climatic chamber and the arrangement of its temperature measuring and control equipment can be modified, provided that the test conditions in accordance with **D-2** and **D-4.3** are observed and that the temperature of the test atmosphere in the useful space is measured. The climatic chamber shall be provided with a suitable door or other aperture capable of being closed, which allows the test room to be charged with specimens and to be ventilated. An example of a condensation water climatic testing device is illustrated in Fig. 5.

Climatic testing devices not equipped with water-filled floor troughs shall be designed in such a way that an adequate formation of condensation water on the specimens is achieved in them.

D-3.2 Installation of the Climatic Chamber

The climatic chamber shall be installed in a room with an ambient atmosphere not containing any corrosive constituents (for example, it shall not be installed in a chemical laboratory), at a room temperature of $26\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and at a relative atmospheric humidity not exceeding 85% relative humidity, in such a way that it is protected against draughts and solar radiation. In the case of comparison tests, the ambient temperature in the installation room shall be $26\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

NOTE — A decrease in the ambient temperature will result in an increase in the quantity of condensation water.

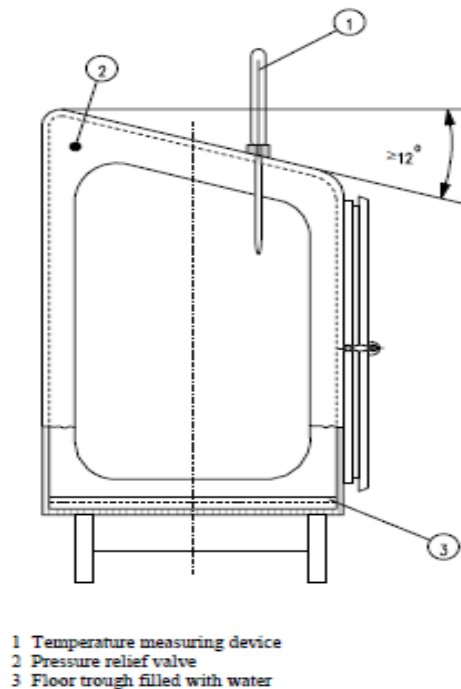


FIG. 5 EXAMPLE OF A CONDENSATION WATER CLIMATIC TESTING DEVICE WITH GLASS

D-3.3 Device for the Accommodation of the Specimens (Specimen Holder)

The device for the accommodation of the specimens shall consist of a corrosion resistant material and shall not promote the corrosion of the specimens. It shall allow the specimens to be arranged in accordance with the requirements of **D-4.3**.

D-4 PROCEDURE

D-4.1 Filling the Floor Trough

The floor trough shall be filled with pure water (distilled water or de-ionized water) in such a way that at least 10 mm depth of water is present at all times during operation.

D-4.2 Specimens

Only specimens which are not capable of influencing one another mutually shall be tested together at any one time. The test specimens shall have a dimension of 100 mm × 100 mm. If the amount of condensation water formed is likely to additionally affect the specimens, then the quantity of condensation water shall be ascertained over a 24 h period, with the aid of a suitable device (see **E-4.4**), for the purpose of describing the test conditions.

D-4.3 Arrangement of the Specimens

The specimens shall be positioned such that they

have an inclination of 20° to the vertical. They shall be arranged in the test cabinet in such a way that they are not in close contact with each other and that they are able to radiate heat adequately. The following minimum spacings shall be observed:

- a) distance from the walls not less than 100 mm;
- b) distance of the bottom edge of the specimens from the surface of the water not less than 200 mm
spacing between adjoining specimens not less than 20 mm; and
- c) Steps shall be taken to ensure that no condensation water is allowed to drip onto the specimens from the walls of the test cabinet or from other specimens arranged overhead, when the specimens are positioned.

D-4.4 Device for the Determination of the Comparison Quantity of Condensation Water (Optional)

The device described below is suitable for the determination of the comparison quantity of condensation water, in case the amount of condensation water formed is likely to additionally affect the specimens. An 18 mm × 180 mm test tube of glass, filled with water, shall be used as the

standard specimen. The condensate dripping from the test tube shall be collected in a graduated measuring cylinder with a nominal capacity of 10 ml, via a glass funnel with a diameter of 55 mm. The device shall be arranged in the test cabinet amongst the other specimens in the same way as described in **D-4.3** for the arrangement of the specimens, and the bottom of the test tube (which shall itself be suspended from a thread of polyamide for example), shall be situated 50 mm above the rim of the funnel placed in the graduated measuring cylinder.

D-4.5 Test Sequence

D-4.5.1 Start-Up

After the specimens have been positioned and the

climatic chamber has been closed, the heating for the floor trough water or for the climatic testing device shall be switched on, and the test cabinet shall be heated up to $40\text{ °C} \pm 3\text{ °C}$. This temperature shall be attained within 1.5 h. Condensation water shall be formed on the specimens.

D-4.5.2 Condensation Water Constant Atmosphere

The temperature prescribed in **D-2**, and therefore the condensation process, shall be maintained in the test cabinet for the entire prescribed duration of the test.

D-4.5.3 End of Test

The test shall be terminated after 480 h.

ANNEX E

(Clauses 4.6 and 4.7.2)

TEST FOR SILVER AND COPPER COATINGS

E-1 PRINCIPLE

The silver and copper deposits are dissolved in nitric acid. Silver is estimated by titrating with ammonium thiocyanate solution. Copper is estimated by comparing the intensity of cuproammonium complex of the test solution with that of a standard copper solution.

E-2 QUALITY OF REAGENTS

Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

E-3 APPARATUS

Nessler cylinders - Two, of 100 ml capacity.

E-4 REAGENTS

E-4.1 Concentrated Nitric Acid — *See* IS 264.

E-4.2 Standard Ammonium Thiocyanate Solution

Dissolve 0.76 g of ammonium thiocyanate in 1 litre of water. Standardize against 0.01 N silver nitrate solution using ferric ammonium sulphate solution as indicator.

E-4.3 Ferric Ammonium Sulphate Solution

Dissolve 8 g of ferric ammonium sulphate in 400 ml of water containing 3 ml to 5 ml of concentrated sulphuric acid (*see* IS 266).

E-4.4 Standard Copper Solution

3.93 g of copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in 200 ml of water and add with stirring 50 ml of concentrated sulphuric acid (*see* IS 266). Cool, transfer to a 1 000 ml volumetric flask and dilute with water up to the mark. Further dilute 100 ml of this solution to 1 000 ml in a volumetric flask. One ml of this diluted solution is equivalent to 0.1 mg of copper (as Cu).

NOTE — AR Grade copper sulphate of purity 99.5 percent (*Min*) is to be used.

E-4.5 Ammonium Hydroxide Solution — Approximately 10 N.

E-5 PROCEDURE

E-5.1 Take a sample of known area for analysis. Remove any paint or varnish from the mirror back with benzene or denatured spirit. Dissolve the copper/silver deposits using minimum quantity of nitric acid distributing the acid over the mirror back with a glass rod. Wash the nitric acid containing copper/silver into a 200 ml porcelain basin and evaporate the solution to dryness carefully on a sand-bath. Dissolve the residue in 3 to 5 drops of nitric acid and a little water. Boil the solution, cool and transfer to a 250 ml volumetric flask and make up the volume to the mark with water.

E-5.2 Determination of Silver

E-5.2.1 The amount of silver deposit may be determined either in accordance with the manual titration method prescribed in **E-5.2.2** or with the use of any commercially available auto titrator. However, in case of any dispute, the manual titration method prescribed in **E-5.2.2** shall be the referee method.

E-5.2.2 Take a 50 ml aliquot of the solution prepared in **E-5.1**, and titrate with standard ammonium thiocyanate solution, using 5 ml of ferric ammonium sulphate solution, until the brown colour appears.

E-5.2.3 Calculation

Silver deposit (expressed as mg/m^2) =

$$\frac{V \times N \times 5 \times 108}{A} \times 100$$

where

V = volume of standard thiocyanate solution added, in ml;

N = normality of the standard ammonium thiocyanate solution; and

A = area of the mirror specimen, in square decimetres.

E-5.3 Determination of Copper

E-5.3.1 Take a 10 ml aliquot of the solution prepared in **E-5.1** and transfer it to a 100ml Nessler cylinder. Add 10 ml of ammonium hydroxide solution and make to 100 ml mark with water. Transfer 10 ml of ammonium hydroxide solution and 5 ml of water to a second 100 ml Nessler cylinder. Add standard copper solution (*see* **E-4.4**) to this Nessler cylinder drop by drop until on dilution to the mark with water, the blue colour of the solutions in both Nessler cylinders matches.

E-5.3.2 Calculation

Copper deposit (expressed as g/m²) =

$$\frac{25 \times V}{A} \times \frac{1}{10}$$

where

V = volume of standard copper solution used, in ml; and

A = area of the mirror specimen in square decimeter.

NOTES

1 A sample mirror 150 mm × 150 mm is usually taken for analysis.

2 It is essential that the evaporation takes place in the absence of hydrochloric acid fumes.

3 Even though the solution of copper/silver deposits may be slightly cloudy, the solution is transferred to the flask without filtering.

E-6 METHOD FOR DETERMINATION OF SILVER COATING IN MIRROR DURING PRODUCTION

E-6.1 General

This method for determination of silver coating in mirrors is to be carried out during production and is intended for factory production and process control. Silver coated sample is to be taken out from mirror production line, prior to paint application. The manufacturer should keep an adequate record of this test. Alternatively, the manufacturer may also use an auto-titrator for the determination of silver coating in mirror during production.

E-6.2 Apparatus**E-6.2.1 Burette****E-6.2.2 Beaker or Porcelain Cup****E-6.2.3 Stirrer****E-6.3 Reagents**

E-6.3.1 Concentrated Nitric Acid (68-70%) — See IS 264.

E-6.3.2 Potassium Thiocyanate Solution — 0.01 N.

E-6.3.3 Ferric Alum Indicator

E-6.3.4 Demineralized Water — see IS 1070.

E-6.4 Procedure

E-6.4.1 Take a 100 mm × 100 mm sample. The edges of the sample must be free from silver deposit.

E-6.4.2 Place the sample in a beaker or porcelain cup and dissolve the silver film with the help of nitric acid to collect the silver deposits in the beaker/cup.

E-6.4.3 Rinse the sample with least quantity of demineralized water and collect the same in that beaker to ensure that all the silver has been removed off the glass.

E-6.4.4 Add 8 to 10 drops of ferric alum (indicator) and stir well.

E-6.4.5 Take 0.01N potassium thiocyanate in burette for titration.

E-6.4.6 Titrate until the first permanent brownish-orange (peach) color is obtained, which is the end point. Note the burette reading.

E-6.5 Calculation

Silver deposit (expressed as mg/m²) = burette reading × 108.

ANNEX F
[Table 2, SI No. (v)]

PENDULUM DAMPING TEST

F-1 GENERAL

A pendulum resting on a coating surface is set into oscillation and the time for the oscillation amplitude to decrease by a specified amount is measured. Shorter the damping time, the lower the hardness.

F-2 APPARATUS

F-2.1 Persoz Pendulum (*see* Fig. 6), consisting of an open framework with an upper cross-bar with two

stainless steel balls, $8 \text{ mm} \pm 0.005 \text{ mm}$ in diameter and of hardness $59 \text{ HRC} \pm 1 \text{ HRC}$ or two tungsten-carbide balls of $(5 \pm 0.005) \text{ mm}$ diameter and of hardness $(1\ 600 \pm 32) \text{ HV } 30$, inset to form a fulcrum, and with a lower cross-bar that also forms the pointer. The two balls shall be set $50 \text{ mm} \pm 1 \text{ mm}$ apart. The total mass of the pendulum shall be $500 \text{ g} \pm 0.1 \text{ g}$, its center of gravity at rest shall be $60 \text{ mm} \pm 0.1 \text{ mm}$ below the fulcrum, and the pointer tip shall be $400 \text{ mm} \pm 0.2 \text{ mm}$ below the plane of the fulcrum.

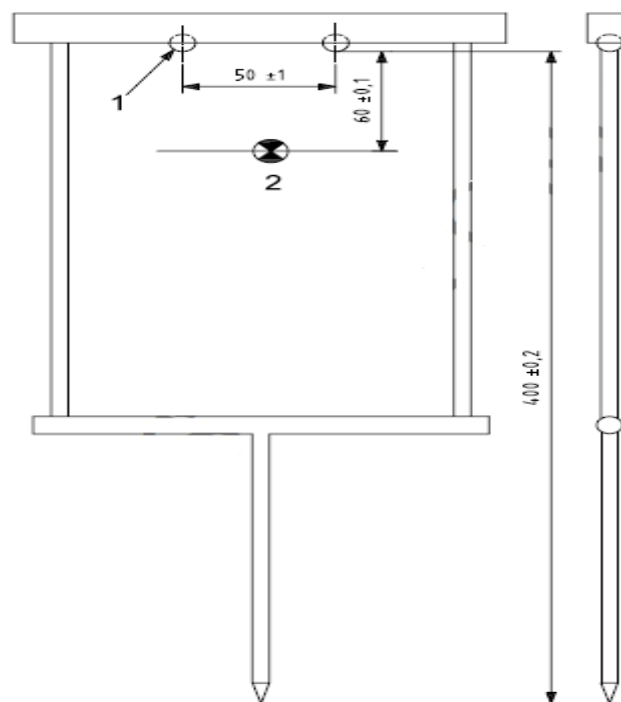


FIG. 6 PERSOZ PENDULUM

F-2.2 Instrument Stand

The stand for supporting test panel and pendulum comprises a heavy supported vertical rod to which is attached a horizontal table with a flat working surface, the dimensions of which may conveniently be $95 \text{ mm} \times 110 \text{ mm}$ and not less than 10 mm thick. The stand also has a stirrup to support the pendulum away from the table and a mechanism for shock-free lowering of the pendulum on to the test panel.

F-2.3 Scale

The front of the stand shall be marked to show angular displacement of the pendulum from a centre

point, indicating the rest position of the pendulum, through 12° and 4° for the Persoz pendulum. The scale may be moved horizontally, and locked in position so that the zero marking and the test position of the pendulum tip coincide. This scale may be marked on a mirror, or a mirror may be placed behind the scale, to assist in eliminating parallax errors during observation.

F-2.4 Stopwatch, or other timing device, for timing the oscillation damping of the pendulum.

F-2.5 Polished Plate (Float) Glass Panel, for calibrating the pendulum.

F-2.6 Test Panel, 100 mm × 100 mm.

F-3 CALIBRATION OF THE PENDULUM

F-3.1 Place the polished glass panel on the panel table and gently bring the pendulum to rest on the surface of the glass. Be sure the pendulum oscillates freely.

F-3.2 Place a spirit level on the glass panel surface. Level the glass panel by means of the adjusting screws at the base of the instrument.

F-3.3 Clean the glass panel by wiping with a soft, lint-free cloth wetted with a suitable solvent.

F-3.4 Clean the fulcrum balls by wiping them with a soft tissue wetted with a suitable solvent. Leave the pendulum in ambient conditions and then bring it to rest on the glass panel.

F-3.5 Deflect the pendulum through 12°, release it and simultaneously start the stopwatch or other timing device.

F-3.6 Determine whether the time for 100 swings of the pendulum is $100 \text{ s} \pm 1 \text{ s}$.

F-3.7 If this value cannot be achieved, re-clean the glass panel and the bearing balls of the pendulum, recheck that the glass panel is level, and retest. Do not adjust the instrument scale at this point.

F-3.8 Deflect the pendulum through 12°, release it and simultaneously start the stopwatch or other timing device.

F-3.9 Determine whether the time for the amplitude of swing to decrease from 12° to 4° is $430 \text{ s} \pm 15 \text{ s}$.

F-3.10 If this value cannot be achieved, repeat the glass panel and instrument checks described in **F-3.7**.

F-4 PROCEDURE

F-4.1 Unless otherwise specified, determine the hardness at $27^\circ\text{C} \pm 2^\circ\text{C}$ and $65\% \pm 5\%$ relative humidity, after holding the test panels (*see F-2.6*) under these conditions for at least 16 h.

F-4.2 Place the test panel on the panel table and gently bring the pendulum onto the panel surface.

F-4.3 Deflect the pendulum through 12° and release it. Simultaneously start the stopwatch or other timing device.

F-4.4 Determine the time for the amplitude of swing to decrease from 12° to 4°. This is the Persoz hardness.

F-4.5 Check for skidding of the pendulum. If the pendulum skidded during the test the obtained result should be considered invalid, and the test repeated.

F-4.6 Repeat steps **F-4.2** to **F-4.5** on at least two other areas of the test panel.

F-4.7 Report the mean and range of the Persoz hardness values in seconds obtained for the test panel.

ANNEX G

(Clause 6)

SAMPLING OF SILVERED GLASS MIRROR**G-1 SCALE OF SAMPLING****G-1.1 Lot**

In a single consignment, all silvered glass mirrors of the same quality of glass used and belonging to the same batch of manufacture shall be grouped together to constitute a lot.

G-1.2 The conformity of the lot to the requirements of this specification shall be ascertained for each lot separately. The number of glass mirrors to be selected for this purpose shall depend on the size of the lot and shall be in accordance with col 2 and 3 of Table 6.

G-1.3 The glass mirrors selected according to col 2 and 3 of the below table shall be examined for visual characteristics (testing for appearance) in two stages. A glass mirror failing to satisfy any of these requirements shall be considered as defective. The lot shall be considered as conforming to the requirements if the number of defective glass mirrors found in the sample at the first stage is less than or equal to the corresponding acceptance number given in col 5 of the Table 6. The lot shall be rejected without any further testing if the number of defective glass mirrors in the sample is greater

than or equal to the corresponding number given in col 6 of the Table 6.

G-1.4 If the number of defective glass mirrors found in the sample lies between 'a' and 'r', a second sample of the size given in col 3 of the below table shall be selected. The lot shall be considered as conforming to these requirements if the number of defective found in the cumulative sample (first and second sample combined) is less than or equal to the corresponding acceptance number given in col 5 of the Table 6; otherwise the lot shall be rejected.

G-1.5 The lot which has passed visual requirements shall be further examined for characteristics requiring destructive testing. For this purpose, a sub-sample of size given in col 7 of the below table shall be taken from those examined for the visual acceptance and found satisfactory. Each of the glass mirrors in sub-sample shall be tested for characteristics given in the Table 2. The test specimens of required dimensions shall be cut from each glass mirror in the sub-sample and subjected to the tests given in annexes and the lot shall be considered as meeting the requirements under this clause if none of the glass mirrors in the sub-sample fails to meet any of these requirements.

Table 6 Scale of Sampling and Permissible Number of Defectives

(Clauses 1.2, 1.3 and 1.4)

Sl No.	No of Mirrors in the Lot	Visual Requirement			Number of Defectives		Sub Sample Size
		Stage	Sample Size	Cumulative Sample Size	a	r	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Up to 1 000 sheets	First	8	8	0	2	2
		Second	8	16	1	2	-
ii)	1 001 to 3 000 sheets	First	13	13	1	3	3
		Second	13	26	2	4	-
iii)	3 001 to 5 000 sheets	First	20	20	2	4	3
		Second	20	40	3	5	-
iv)	5 001 sheets and above	First	32	32	3	5	5
		Second	32	64	6	7	-

ANNEX H

(Informative)

MIRRORS

H-1 GENERAL

The type of mirror and fixing should be suitable for the environment. Consideration and recognition should be given with regard to durability of the coating and distortion free image. For all installations, especially on ceilings the appropriate building safety and fixing regulations should be followed.

H-2 FACTORS AFFECTING DURABILITY

The reflective silver layer and the protective coatings(s) of the mirror are susceptible to being damaged or corroded. This will largely depend on the environment in which the mirror is used. The following rules should always be considered.

H-2.1 Between the mirror and wall or any other mounting surface air circulation should be allowed for. There should be a gap of at least 5 mm for mirrors less than 1m high or a gap of 5 mm to 10 mm for mirrors with height of more than 1m in order to ensure good ventilation.

H-2.2 Where more than one mirror is fixed to the same surface, it should be ensured that there is a gap between all butting edges. As an assembly guide, a suitable 1 mm distance piece might be inserted during fixing.

H-2.3 The mounting materials used should not be of an aggressive nature.

H-2.4 When mirrors are inserted into profiles, the edges can be corroded by condensation, bathing lotions, cleaning chemicals etc. which may remain within the profile. To avoid this, the mirror should be mounted on small suitable blocks within the profile.

H-2.5 The surface and body of the substrate material to which the mirror is to be fixed should be clean, dry, free of humidity, acid, alkali and any other aggressive materials and, when required, should be appropriate for the use of adhesives.

H-2.6 Surfaces to be in contact with adhesives should be adequately prepared. For cleaning, surgical spirit can be used.

H-2.7 The adhesive manufacturer's instructions should always be strictly observed.

H-2.8 All adhesives used should be compatible with the mirror coating. By using the recommended

adhesives for the appropriate use, mirror coating damage will be minimized.

H-2.9 All adhesives, double sided tapes etc. used for fixing should be applied vertically.

H-2.10 The selection and application of adhesives, along with the choice of substrate and preparation for fixing the mirror, is solely at the discretion and risk of the fixer.

H-2.11 If a mirror's effect is enhanced by illumination (for example, by spotlight), excessive warming of the mirror should be avoided to prevent deterioration of the silver, or fracture of the glass.

H-2.12 When using mirrors in horse riding halls, swimming pools, medical baths, saunas and rooms adjoining them and any other rooms with constantly high humidity, no guarantee for the durability of the coating can be assumed, except for warranted mirrors specific to those applications.

H-3 FACTORS AFFECTING IMAGE DISTORTION

In order to ensure a mirror image free of distortions, the mirror should be fixed flat, stress free and in accordance with the following principles.

H-3.1 Mirrors should be fixed so that the weight is not supported by the edges in order to avoid bending and thus distortion.

H-3.2 When adhering a mirror to a substrate material, flatness should be ensured to avoid distortion.

H-3.3 When fixing a mirror using adhesive tape, care should be taken that pressing does not cause distortion. If possible, the support base material should be adhered to the mirror (not the other way around) and subsequently the assembled mirror fixed mechanically.

H-3.4 When placing several mirrors next to each other to create a mirror wall, optical breaks in the image at the joints can be positively influenced by using the adjustment tolerances of the fixing system.

H-3.5 The mirror should be fixed securely but free from stress to avoid distortion and risk of breakage. Wall unevenness should be levelled by using suitable soft spacers.

ANNEX J
(Foreword)

COMMITTEE COMPOSITION

Glass, Glassware and Laboratoryware Sectional Committee, CHD 10

<i>Organization</i>	<i>Representative(s)</i>
CSIR – Central Glass & Ceramic Research Institute, Kolkata	DR SUMAN KUMARI MISHRA (Chairperson)
AGI Glaspac	SHRI RAJESH KHOSLA SHRI VISHWANATH AMBADIPUDI (<i>Alternate</i>)
Asahi India Glass Limited	SHRI NAGENDRA KUMAR SHRI NAVIN RAI (<i>Alternate</i>)
Bhabha Atomic Research Centre, Mumbai	DR (SHRIMATI) MADHUMITA GOSWAMI DR P. N. NANDI (<i>Alternate</i>)
Borosil Ltd	SHRI SHRIKANT GANGAN SHRI SATISH CHITRIV (<i>Alternate</i>)
Building Materials & Technology Promotion Council	SHRI A. K. TIWARI DR AMIT RAI (<i>Alternate</i>)
Central Building Research Institute, Roorkee	DR NAVJEEV SAXENA SHRI AJAY CHAURASIA (<i>Alternate</i>)
Centre for the Development of Glass Industry	SHRI SANJEEV CHINMALLI SHRI DEVENDRA SAH (<i>Alternate</i>)
Confederation Construction Products and Services (CCPS)	SHRI DEEPAK GAHLOWT SHRIMATI SARITA BALODHI (<i>Alternate</i>)
Controllorate of Quality Assurance(Materials)	SHRI SUNIL KUMAR SHRI BRIJESH SINGH TOMAR (<i>Alternate</i>)
CSIR - Central Glass & Ceramic Research Institute	DR K. ANNAPURNA SHRI SITENDU MANDAL (<i>Alternate</i>)
Department for Promotion of Industry and Internal Trade	SHRI T. S. G. NARAYANNEN SHRI UDAY SINGH MINA (<i>Alternate</i>)
Federation of Safety Glass	SHRI SHARANJIT SINGH SHRI GURMEET SINGH (<i>Alternate</i>)
Glazing Society of India	SHRI G. N. GOHUL DEEPAK
Gold Plus glass industry Ltd	SHRI VIVEK DUBEY SHRI PREM DUTT (<i>Alternate</i>)

<i>Organization</i>	<i>Representative(s)</i>
Govt College of Engineering and Ceramic Technology	DR RITUPARNO SEN DR (MS) KABERI DAS (<i>Alternate</i>)
Hindustan Glass Works Ltd	SHRI VARUN GUPTA SHRI K. ARVIN (<i>Alternate</i>)
Hindustan National Glass & Industries Ltd	SHRI PAWAN BHARADWAJ SHRI PRASANTA ASH (<i>Alternate</i>)
Indian Institute of Packaging	DR TANWEER ALAM SHRI BIDHAN DAS (<i>Alternate</i>)
National Test House, Kolkata	DR S. K. KULSHRESTHA SHRI D. V. S. PRASAD (<i>Alternate</i>)
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Shree Labware and Process Systems	SHRI A. N. S. KUMAR
Shriram Institute for Industrial Research	SHRI ANEESH KUMAR SHRI JOY BANERJEE (<i>Alternate</i>)
SISECAM Flat Glass India Pvt Ltd	SHRI PARAG SHAH
The All India Glass Manufacturers Federation	SHRI SOURABH KANKAR SHRI VINIT KAPUR (<i>Alternate</i>)
Voluntary Organization in Interest of Consumer Education (VOICE)	SHRI B. K. MUKHOPADHYAY SHRI K. C. CHAUDHARY (<i>Alternate</i>)
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(CHEMICAL), BIS

Flat and Coated Glass Subcommittee, CHD 10:6

<i>Organization</i>	<i>Representative(s)</i>
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Gold Plus Glass Industry Ltd	SHRI VIVEK DUBEY SHRI PREM DUTT (<i>Alternate</i>)
Gujarat Guardian Ltd.	SHRI SANDEEP SINGH
M/s Diamond Tuff Glass Saint - Gobain Glass India Ltd	SHRI PRAVEEN SAINI SHRI CHIRANJIT ROY
The All India Glass Manufacturers Federation	SHRI SOURABH KANKAR SHRI VINIT KAPUR (<i>Alternate</i>)

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